Retrograde Brachial Aortography

Its Use in the Diagnosis of Patent Ductus Arteriosus and Coarctation Of the Aorta in Infancy

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• **Patent ductus arteriosus and coarctation of the aorta are among the commonest causes of congestive heart failure early in life. When medical therapy fails to control heart failure in these cases, surgical division of the ductus or excision of the coarcted segment can be performed. But the recognition of these anomalies in infancy is more difficult than in childhood or adult life.**

Retrograde thoracic aortography is a technique which permits positive identification. In the presence of patent ductus arteriosus, opacification of the pulmonary arteries from the descending aorta will be clearly shown; if coarctation is present, its position, severity, and the length of the involved segment can usually be demonstrated. Properly employed, retrograde brachial aortography is a relatively safe and effective diagnostic procedure.

PATENT DUCTUS ARTERIOSUS and coarctation of the aorta are among the commonest causes of congestive heart failure in early life.[2-4,6,8] When intractable under medical management, both are amenable to surgical treatment. With modern methods both are diagnosable, yet occasionally are not recognized in time.

In infancy, the ordinary clinical and roentgenologic signs may not suffice for exact diagnosis. Patent ductus arteriosus may exist without the classical "machinery" murmur, and may be difficult to differentiate from intracardiac left-to-right shunts. The diagnosis of coarctation of the aorta, usually clear-cut in adults on clinical grounds alone, is less certain in infants, in whom blood pressure measurements may be difficult to obtain. Even when the diagnosis can be made, the length and position of the stenotic segment may affect the feasibility of operation.

Retrograde brachial aortography is an efficient diagnostic technique in such infants.

Technique

The left brachial artery is cannulated (Figure 1) and the opaque medium is injected counter-current toward the aorta. Serial roentgenograms record the passage of the opaque medium into the aortic arch and its branches (see Figure 1). (Details of premedication, anesthesia and electrocardiographic recordings, were described in a previous communication.)

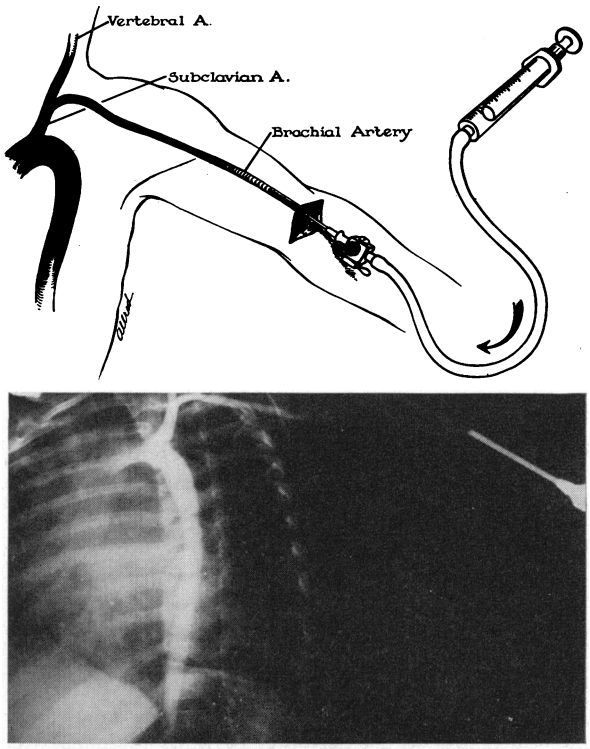

Figure 1.—Technique of retrograde brachial aortography. *Upper:* The largest possible Robb needle is inserted in the brachial artery and attached to a three way stop-cock. A short length of flexible rubber tubing is attached to the stop-cock at one end, and the filled syringe at the other. *Lower:* Roentgenogram following injection. The needle is in the left brachial artery, and the injection has just been completed. The brachial, axillary and subclavian arteries are opacified, as is the arch of the aorta and the descending thoracic aorta.

Material

Retrograde aortograms were performed in 84 patients, 67 of them less than three years old, 50 less than 12 months, and 32 less than six months. Thirty-five per cent Diodrast® was injected into the brachial artery in 77 cases, and a 70 per cent to 75

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TABLE 1.—*Findings in 84 Retrograde Thoracic Aortograms*

Diagnosis	No. of Cases
Patent ductus arteriosus	14
Coarctation of the aorta	15
Total interruption of aortic arch	1
Right aortic arch with retroesophageal aortic diverticulum	1
Right aortic arch	1
Reverse patent ductus arteriosus*	2
Normal	44
Unsatisfactory	6
Total	84

*Angiocardiograms were required to demonstrate reversal of flow. In an additional two cases in which coarctation of the aorta was present, reversal of flow through a patent ductus arteriosus was also demonstrated.

per cent concentration of the opaque medium into the carotid or brachial artery in seven cases. The indication for the procedure in most cases was persistent congestive heart failure, frequently associated with recurring pulmonary infection. The primary effort was to ascertain whether patent ductus arteriosus or coarctation of the aorta was present.

Results (Table 1)

In 14 cases, the presence of patent ductus arteriosus with left-to-right shunt was shown either by demonstration of the ductus itself (Figure 2) or by indirect evidence—immediate opacification of the pulmonary arteries from the descending limb of the aortic arch (Figure 3). Within two to three seconds after injection, left atrial, left ventricular and subsequent aortic opacification were observed. Eleven of the 14 patients were below the age of one year. In all instances but one, the diagnosis was proved at operation.

The presence of coarctation of the aorta was demonstrated in 15 patients. In most instances the site of coarctation was distal to the origin of the left subclavian artery, and the zone of constriction was localized (Figures 4 and 5). In ten cases the diagnosis was proved at operation and in two at necropsy. Ten of the 15 patients were below the age of one year.

In one case, complete interruption of the aortic arch, associated with reversed flow through the ductus arteriosus was shown. In another case, a retroesophageal aortic diverticulum was opacified.

Forty-four studies were normal, and six examinations were unsatisfactory.

There were three errors in diagnosis, all of them included in the six cases in which the studies were unsatisfactory. In one, the diagnosis of patent ductus arteriosus was suggested and proved wrong; in another, the result of examination was interpreted as negative for ductus and a ductus was subsequently proved to be present; and in the third case it was stated that there was "suggestive but incon-

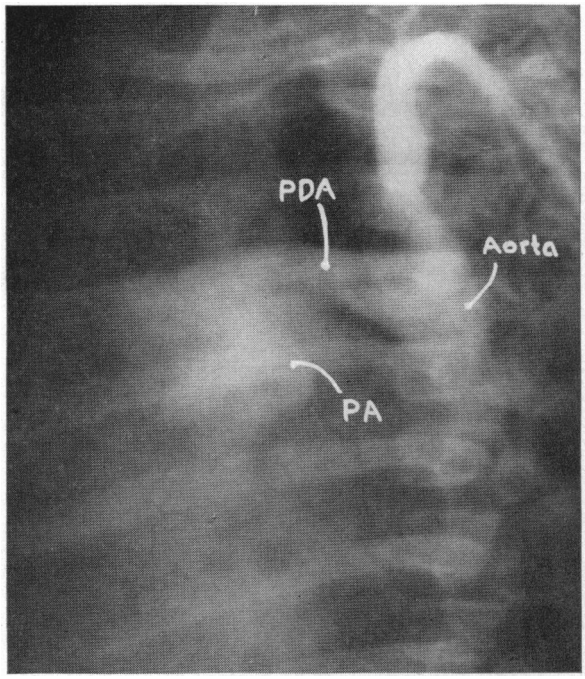

Figure 2.—Patent ductus arteriosus in a seven-month-old girl. Retrograde brachial aortogram. The opaque medium has reached the aorta from the subclavian artery, and clearly delineates the ductus arteriosus (PDA). The pulmonary artery (PA) is opacified because of the left to right shunt through the ductus.

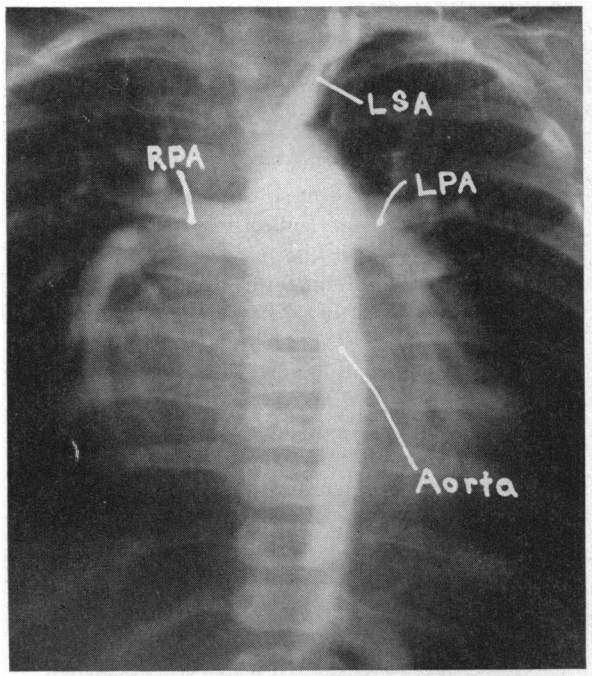

Figure 3.—Patent ductus arteriosus in an eight-month-old girl. Retrograde brachial aortogram demonstrates sequential opacification of the left subclavian artery (LSA), the aorta, and the right (RPA) and left (LPA) main pulmonary arteries, proving the existence of an aortic pulmonary communication. That this is a patent ductus arteriosus rather than an aortic septal defect may be inferred from the fact that the ascending aorta is not opacified.

clusive" evidence of a patent ductus arteriosus and no ductus was found at operation. All three of these studies would now be considered unsatisfactory and a repeat examination would be done.

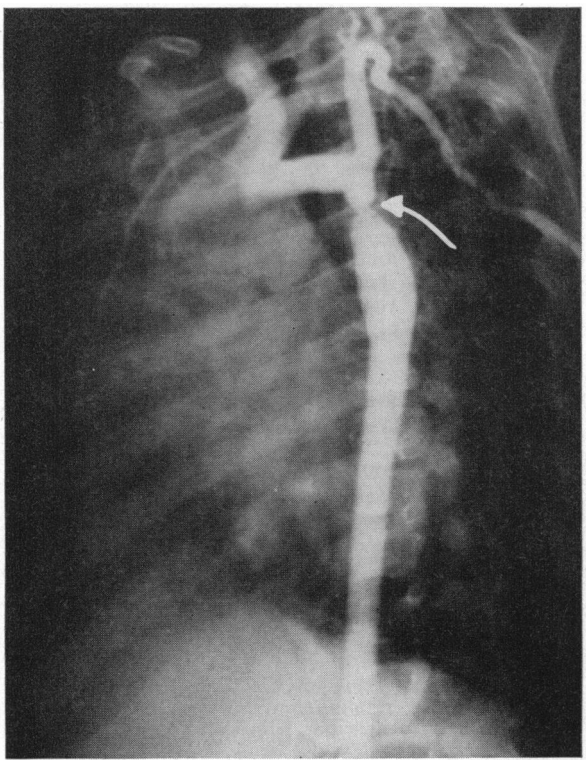

Figure 4.—Coarctation of the aorta in a three-month-old boy. Retrograde brachial aortogram. The classical "adult" (localized) type of coarctation is visible. The ascending aorta is somewhat dilated, in contrast to the transverse portion of the arch and the isthmus. Note the large tortuous parascapular artery. The internal mammary arteries are also prominent.

TABLE 2.—*Reactions Following Retrograde Aortography with 35 Per Cent Diodrast in 77 Cases*

Reactions	No. of Patients
Irregular, labored, or rapid respirations	8
Vomiting (all patients had general anesthesia)	6
Slight tremor	1
Disparity in pupil size	1
*Electrocardiographic changes:	
T-wave changes	4
Ventricular premature beats	2
Nodal rhythm	1
Tachycardia	3

*Electrocardiograms were obtained in only 35 of the cases.

Reactions

Among the 75 cases in which retrograde aortograms were performed, using brachial injection of 35 per cent Diodrast as the medium, the incidence of significant reactions was not high and there were no deaths (Table 2).

In seven instances retrograde brachial carotid injection with a 70 per cent to 75 per cent concentration of opaque medium was employed. Reactions in these cases are listed in Table 3.

Most of the deaths reported in the literature followed the use of a 70 per cent medium or injection into the carotid artery.[5,7,9] Since a 30 to 35 per cent concentration of opaque medium is adequate for demonstrating the aorta in infancy, no higher concentration need be employed.

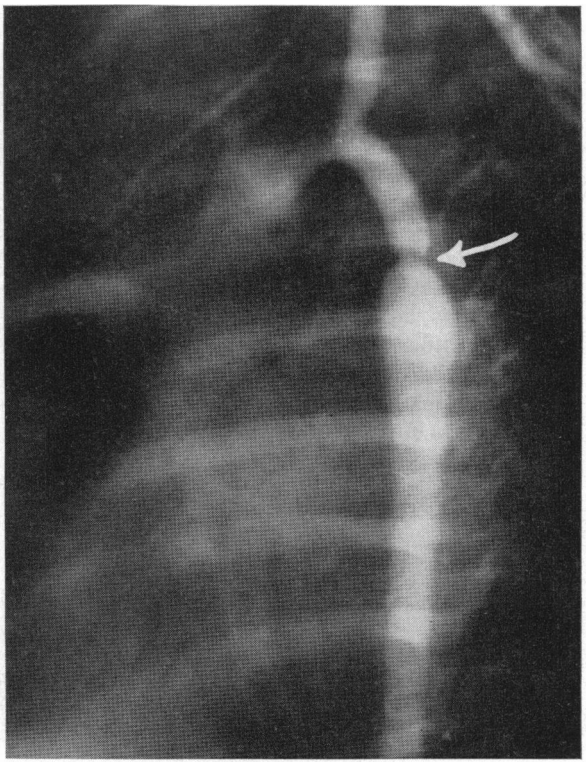

Figure 5.—Coarctation of the aorta in a two-month-old infant. Retrograde brachial aortogram demonstrates a localized zone of stenosis (arrow) at the termination of the isthmus of the aortic arch. Beyond this area of narrowing, a distinct poststenotic dilatation involving a segment about 1.5 cm. is visible.

TABLE 3.—*Reactions Following Retrograde Aortography in Which a 70 Per Cent Concentration of Medium Was Used in Seven Cases*

Patient No.	Medium	Concentration	Site of Injection	Reaction
1	Urokon	70 per cent	Brachial artery	Death
2	Diodrast	70 per cent	Carotid artery	Laryngospasm
3	Diodrast	70 per cent	Carotid artery	Hemiplegia
4	Neo-Iopax	75 per cent	Carotid artery	Severe neck pain
5-7	Diodrast	70 per cent	Carotid artery	None

DISCUSSION

All the patients with patent ductus arteriosus had an excellent response to closure of the ductus. Most of the patients with coarctation were relieved of heart failure and of significant disability. Since special diagnostic procedures were employed only on patients who were severely ill, operation was not without hazard; but the prognosis with medical management seemed grave.

The diagnosis of patent ductus arteriosus may be made in infancy by cardiac catheterization. If the pulmonary artery is not catheterized, the diagnosis cannot definitely be established. Furthermore, even if the pulmonary artery is catheterized, the distinction of patent ductus arteriosus from ventricular septal defect is not always possible unless the ductus itself is entered. In the largest published series of catheterizations in infancy, failure to enter the pulmonary artery was relatively common in patients under the age of 12 months.[11] Hence the authors have relied on aortography in infancy and have reserved cardiac catheterization for older age groups. Obviously, the main objective is to establish the diagnosis of an operable anomaly, and to this end both techniques may be effectively utilized.

The hazards of retrograde aortography have frequently been stressed. The authors' experience with the retrograde brachial infection of 35 per cent Diodrast has been fortunate, but not unique.[8] A survey is under way to determine the hazards of retrograde aortography as employed at a large number of institutions. Preliminary analysis suggests that the complications of retrograde aortography have usually been most striking when high concentrations of the opaque media have been injected into the carotid artery.

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REFERENCES

1. Abrams, H. L., and Kaplan, H. S.: Angiocardiographic Interpretation in Congenital Heart Disease, Charles C. Thomas, Springfield, Ill., 1956.

2. Adams, P., Jr., Adams, F. H., Varco, R. L., Dammann, J. F., Jr., and Muller, W. H.: Diagnosis and treatment of patent ductus arteriosus in infancy, Pediat., 12:664-673, Dec. 1953.

3. Bahn, R. C., Edwards, J. E., and Du Shane, J. W.: Coarctation of the aorta as a cause of death in early infancy, Pediat., 8:192-203, Aug. 1951.

4. Briggs, J. F.: Left heart failure in the newborn, Dis. Chest, 26:207-209, Aug. 1954.

5. Chou, S. N., French, L. A., and Peyton, W. T.: Cerebral complications following cardioangiography, Am. J. Roentgenol., 73:208-210, Feb. 1953.

6. Dammann, J. F., Jr., and Sell, C. G. R.: Patent ductus arteriosus in the absence of a continuous murmur, Circulation, 6:110-124, July 1952.

7. Gasul, B. M., Weiss, H., Fell, E. H., Dillon, R. T., Fisher, D. L., and Marienfeld, C. J.: Angiocardiography in congenital heart disease correlated with clinical and autopsy findings, Am. J. Dis. Child., 85:404-443, April 1953.

8. Keith, J. D., and Forsyth, C.: Aortography in infants, Circulation, 2:907-914, Dec. 1950.

9. McAfee, J. G.: Angiocardiography and thoracic aortography in congenital cardiovascular lesions, Am. J. Med. Sci., 229:549-582, May 1955.

10. Rogers, H. M., Rudolph, C. C., and Cordes, J. H., Jr.: Coarctation of the aorta in infancy: Report of two cases with deaths from left ventricular failure, Am. J. Med., 13:805-808, Dec. 1952.

11. Zeigler, R. F.: Clinical cardiac catheterization in infants and children, Ped. Clin. N. Amer., pp. 93-113, Feb. 1954.